DC Motor Starting Resistor Steps

Total starting resistance, number of steps and the resistance to cut out at each step for a DC motor starter between chosen maximum and switching currents.

Method: Geometric grading of starter resistance

Input parameters

Unit system: SI

Parameter	Value	Unit
Supply voltage	250.00	V
Armature circuit resistance	0.40000	Ω
Maximum starting current	350.00	A
Current at which a step is cut out	200.00	A

Calculated results

Parameter	Value	Unit
Total circuit resistance at standstill	0.71429	Ω
Ratio I_min/I_max	0.57143	
Number of resistor steps	2.0000	
Resistance cut out at the first step	0.30612	Ω
Resistance cut out at the last step	0.008163	Ω
Current peak when the last step is shorted	204.08	A

Notes for this case

• At standstill R_tot = V/I_max. As the motor speeds up the back EMF rises and current falls to I_min; cutting out a section then restores I_max, so each total resistance is k = I_min/I_max times the one before: R_1 = R_tot, R_2 = kR_tot, … until the next value would fall below R_A. The last step shorts what remains and its current peak shows whether a further step is needed. Pick I_min to give a reasonable number of steps (Chapman uses this procedure).

Formula and method

$$R_{tot} = \frac{V_T}{I_{max}}, \quad R_{j+1} = R_j \frac{I_{min}}{I_{max}}$$

Variables

V_T	Supply voltage	V
R_A	Armature circuit resistance	Ω
I_{max}	Maximum starting current	A
I_{min}	Current at which a step is cut out	A
R_{tot}	Total circuit resistance at standstill	Ω
k	Ratio I_min/I_max	-
n	Number of resistor steps	-
ΔR_1	Resistance cut out at the first step	Ω
ΔR_n	Resistance cut out at the last step	Ω
$I_{peak,n}$	Current peak when the last step is shorted	A

Method and standards

Starter steps.

Assumptions and limits

- Steps cut at the same current; inductance and brush drop neglected.

References

Geometric grading of starter resistance

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/motors/dc-motor-starter-resistors

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.